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(54) Controlling an electric heater unit for an electric ceramic hob

(57) Control means for an electric heater unit comprising an electric heater (3) positioned below a glass ceramic hob plate (1), comprising a thermally conductive rod (5) positioned below the hob plate in proximity of the heater element, and a thermally responsive switch (7) for controlling a warning indication on the heat output of the element and connected thermally to one end of the rod (6). The rod has a thermal conductivity in excess of 100 Watts/(mK), and the switch is set to trigger at a predetermined temperature which is greater than 300°C. The rod may be of copper, silicon carbide or aluminium nitride in a protective glass sheath, bent so as to cover a larger area of the hot plate and have a flat surface held in good thermal contact with switch 7. Two switches can be used to control both the heat output and a warning indicator.

Fig.1.

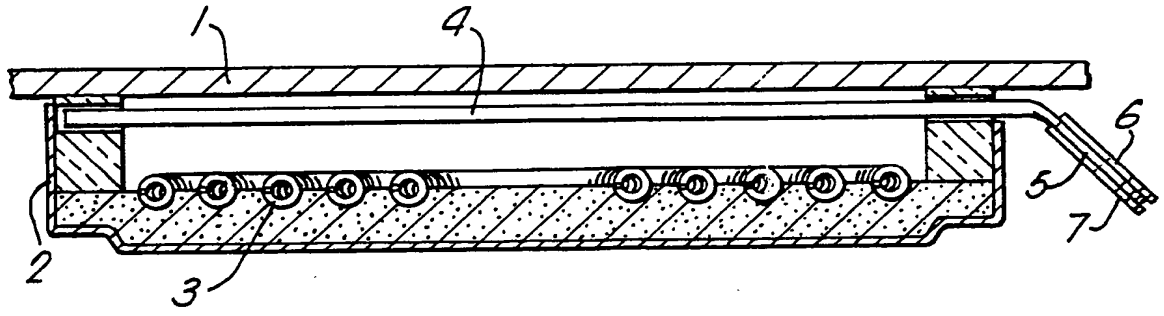

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Fig.1.

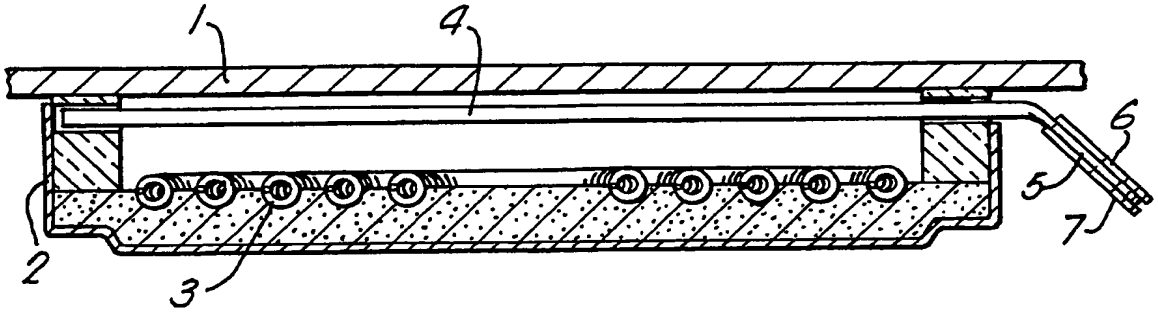
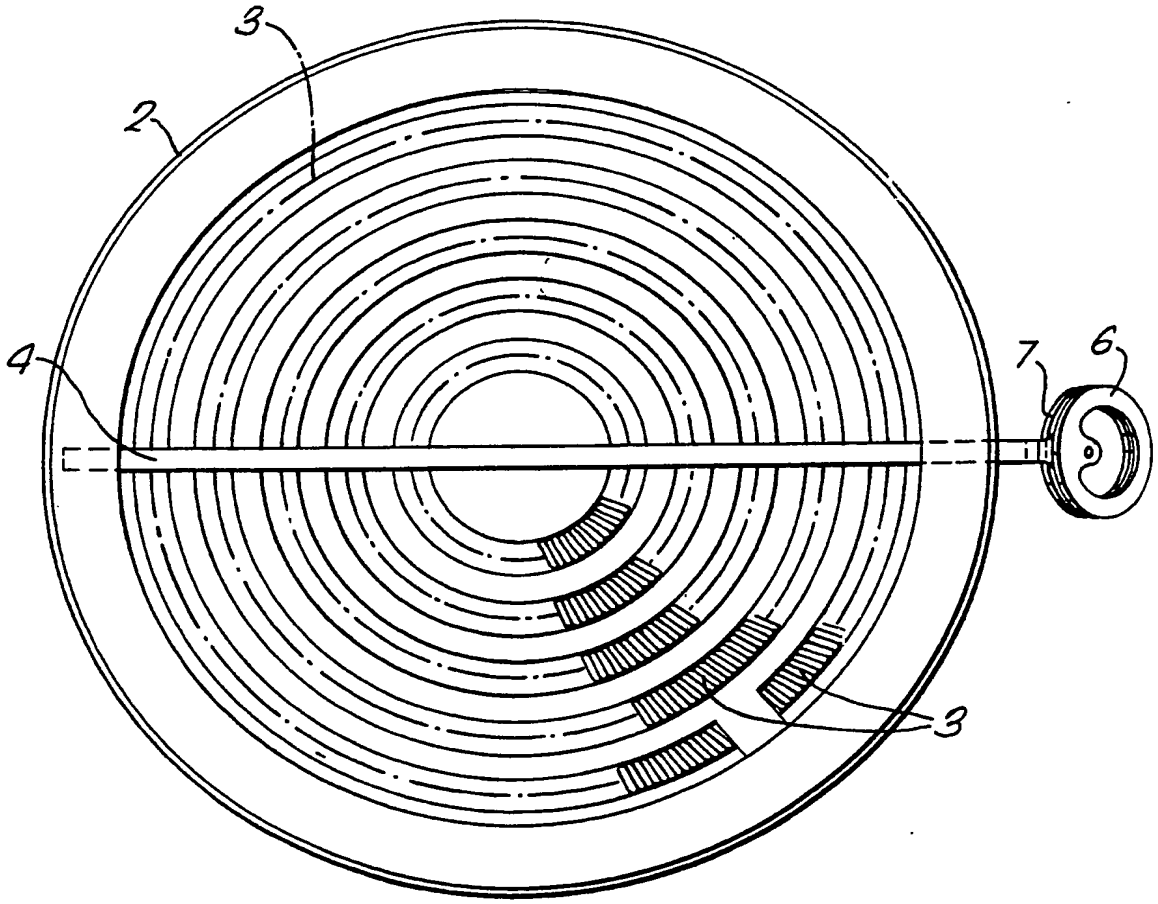


Fig.2.



HT/3480

Control Means for an Electric Heater Unit

This invention relates to electric heater units and to control means for such units, and is particularly useful in heater units for electric hobs, especially ceramic hobs.

When an electric heater element, whether of the resistive type or comprising one or more tungsten halogen lamps or a combination thereof, is positioned below a glass ceramic hob plate, there is a risk that if the element is energised and no cooking utensil is placed on the hob, or there is an inadequate thermal coupling betwen the utensil and the hob, the temperature of the glass ceramic plate will rise to a point at which it is damaged. In order to avoid this the heater unit may be provided with control means to reduce or switch off the power supplied to the heater elements when this excessive temperature is reached.

One form of such control means consists of a rod of material having a high co-efficient of thermal expansion coupled to a snap action switch which is triggered by relative expansion of the rod and a surrounding tube. It is also known to use a thermally conductive rod arranged diametrically across the heater element beneath the hob plate, the control means having a bimetal switch connected thermally to the end of the rod located outside the heated area. The present invention provides an alternative control means which is less expensive, is simpler in construction and requires virtually no adjustment or maintenance.

According to one aspect, the invention provides an electric heater unit adapted to be positioned below a ceramic hob plate, comprising : an electric heater element; a thermally conductive probe, of conductivity in excess of about 100 Watts/(mK) and a melting point in excess of 500°C, which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate; and a temperature sensor connected thermally to one end of the probe and arranged to switch on an electric hob warning indicator when the sensed temperature exceeds a predetermined threshold corresponding to the highest hob plate temperature safe to touch. This has the advantage of combining a heater control with a hob-warning indicator in a particularly simple manner.

According to a second aspect, the invention provides an electric heater unit adapted to be positioned below a ceramic hob plate, comprising : an electric heater element; a thermally conductive elongate probe, and a melting point in excess of 500°C, of conductivity in excess of about 100 Watts/(mK) which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate; and two bimetal switches connected thermally to the same end of the probe and set to trigger at substantially different temperatures. One switch may be used to control the heater, the other to control a hob warning indicator.

In a third aspect, the invention provides control means for an electric heater unit comprising at least one electric heater element positioned below a ceramic hob plate, the control means comprising a thermally conductive elongate probe which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor for controlling the heat output of the element, the sensor being connected thermally to one end of the probe, and the sensor being arranged to trigger when the probe end reaches a predetermined temperature in excess of 300°C.

This is considered to be a temperature which would soon be reached by the probe once the hob plate approached the normal cooking temperature of about 600°C. Such a trigger temperature must of course exceed the usual ambient temperature in the region of the

sensor, and it has been discovered that this ambient temperature may be as high as 200°C, especially where the sensor is relatively close to the element.

The invention in a further aspect provides an electric heater unit for use with an electric hob, the unit comprising a generally planar electric heater element and control means comprising a thermally conductive elongate probe in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor connected thermally to one end of the probe for controlling the heat output of the element, the probe being a rod having at least one bend in a plane parallel to the plane of the element and within the boundary of the heater element as projected normally onto the plane of the probe. This enables the probe to respond to the temperatures of the hob plate over a wider area of the heater element than would be possible with a straight probe, so that the probe is quicker to respond to fault conditions where the temperature distribution is uneven.

Further, in order to maximise the thermal contact between the probe and the sensor, and to ensure a reliable coupling which will not fail in use, it has been found beneficial to couple them directly together without brazing or riveting but with a large contact area, and in accordance with a further aspect the invention provides control means for an electric heater unit comprising at least one electric heater element positioned below a ceramic hob plate, the control means comprising a thermally conductive, generally cylindrical, elongate probe which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor for controlling the heat output of the element, the sensor being connected thermally to one end of the probe, the said end of the probe having a surface profiled such as to be complementary to a corresponding surface of the sensor, the complementary surfaces being held in intimate thermal contact.

One embodiment of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which :

Figure 1 is an elevational section through a hob plate heater unit comprising control means in accordance with the present invention, and

Figure 2 is a section in plan taken through the control means.

A glass ceramic hob plate 1 has supported below it a conventional disc-shaped electric heater unit comprising one or more heater elements 3. The element shown is of the resistive type, but the invention is equally applicable to heater units comprising one or more tungsten halogen filament lamps. The heater element or elements 3 are thermally insulated by means of a casing having a cylindrical side wall and a circular base.

Extending diametrically across the heater element 3 immediately below the hob plate is a thermal probe in the form of a cylindrical rod 4 of a material having a high thermal conductivity.

The thermal conductivity of the rod is at least 100 Watts/(mK), and preferably greater than 200 Watts/(mK). The rod should also be capable of withstanding temperatures of at least 500°C corresponding to temperatures of the hob plate in excess of the normal cooking temperatures of 500° to 600° or even 700°C. At normal cooking temperatures, the rod should reach approximately 300° to 400°C, depending on its material and size and its proximity to the element 3. One suitable material for the rod is copper, whose conductivity is almost 400 Watts/(mK). The rod is plated for the purpose of protecting the material of the rod from corrosion. Suitable protective plating materials include silver, gold and alloys thereof, or other metals such as nickel, rhodium or chromium or non-metals which do not deteriorate at the operating temperature of the heater unit. The rod could, for example, be coated, e.g. by spray coating, with an oxide layer, for example of aluminium oxide, for corrosion resistance.

Some copper alloys, such as chromium copper and chromium-zirconium-copper, are also appropriate materials for the rod, and are more resistant to corrosion. Highly thermally-conductive ceramics materials can also be used, for example silicon carbide whose conductivity can be as high as 160 Watts/(mK),

and aluminium nitride, whose conductivity can exceed 140 Watts/(mK) particularly with doping.

One end of the rod 4 extends beyond the main enclosure of the electric heating unit and is flattened, as shown at 5. The flattened portion is held against a bimetal strip 6, typically by means of a rivet, such that good thermal contact is maintained. A heat transfer compound may be employed between the rod 4 and strip 6, to further improve the thermal contact. The movement of the bimetal strip, when a pre-determined temperature is reached, is sufficient to operate an adjacent proximity switch (NOT SHOWN), which interrupts or reduces the power to the heater. In this example, the strip is bistable. The strip 6 is located further than the main part of the probe 4 from the heater element or elements 3, and is insulated thermally from the elements 3 by the side wall of the casing.

The switch associated with the strip 6 is set to open at a predetermined temperature which should be at least 300°C to 400°C, because the ambient temperature around the switch may reach 200°C even in normal operating conditions.

A second, similar, bimetal strip 7 is set to operate a further switch (NOT SHOWN) at a substantially lower temperature, to control a neon or other visible indicator, warning that the surface of the hob is above a certain temperature, such as 40°C, safe to touch.

The switches and the rod end are enclosed within a thermally insulating casing (not shown). Alternative forms of switch include the disc type thermal sensor, the memory metal operated snap-acting switch, the curie point operated magnetic switch and the electronic switch, e.g. a thermistor, thermoelectric device or temperature-dependent resistor, coupled through appropriate circuitry to an electronic switching means. It would be possible, however, for the temperature of the rod to be sensed by an alternative form of sensor connected to a current control circuit remote from the heater unit. By differentiating signals so obtained and comparing them electronically to a reference, devices such as a pan presence sensor, a pan suitability sensor and a pan contents sensor, may be incorporated.

Alternative forms of the thermal probe 4, 5 would include rods of non-circular cross-section, preferably with a flat surface at least at one end, and rods having at least one bend in a plane parallel to the plane of the heater element 3, within the circular boundary of the heater element periphery. If the probe is bent, e.g. to a serpentine configuration, it sees a greater area of the hob plate adjacent the element, so that the probe is more likely to detect dangerous "hot spots" as a result e.g. of a saucepan having a distorted undersurface.

A further alternative may employ a tube of quartz or high temperature glass around the rod 4 to provide support and/or electrical insulation.

A further probe could be provided, e.g. within the same outer tube or else separate, and extending for example into the peripheral "dead space" within the cylindrical insulated casing but unoccupied by any part of the element or elements 3. This probe could be connected to control an independent warning circuit for energising the hob warning light; as with the hob warning circuit associated with strip 7, the warning indication would stay on while the hob plate cools after de-energisation of the heater elements.

Although in the example described and shown in the drawing the thermal sensor is outside the heated area, it would be possible, with bimetal strips currently available, to position one or both sensors closer to the heater, inside the casing 2.

Further, although two sensors have been described, it would be possible to have only one such sensor, connected to control a hob warning indicator.

CLAIMS

1. An electric heater unit adapted to be positioned below a ceramic hob plate, comprising : an electric heater element; a thermally conductive elongate probe, of conductivity in excess of about 100 Watts/(mK) and a melting point in excess of 500°C, which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate; and a temperature sensor connected thermally to one end of the probe and arranged to switch on an electric hob warning indicator when the sensed temperature exceeds a predetermined threshold corresponding to the highest hob plate temperature safe to touch.

2. An electric heater unit according to Claim 1, in which the hob warning temperature sensor consists of a bimetal switch which triggers at the threshold temperature.

3. An electric heater unit according to Claim 1 or 2, comprising a further temperature sensor connected thermally to the same end of the probe and arranged electrically to reduce the heat output of the heater element in response to the sensed temperature exceeding a further predetermined threshold substantially greater than that for the hob warning indicator.

4. An electric heater unit according to Claim 3, in which the further temperature sensor comprises a bimetal switch which triggers at the further predetermined temperature.

5. An electric heater unit adapted to be positioned below a ceramic hob plate, comprising : an electric heater element; a thermally conductive elongate probe, of conductivity in excess of about 100 Watts/(mK) and a melting point in excess of 500°C, which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate; and two bimetal switches connected thermally to the same end of the probe and set to trigger at substantially different temperatures.

6. An electric heater unit according to any preceding claim, in which the probe has a thermal conductivity in excess of 200 Watts/(mK).

7. Control means for an electric heater unit comprising at

least one electric heater element positioned below a ceramic hob plate, the control means comprising a thermally conductive elongate probe which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor for controlling the heat output of the element, the sensor being connected thermally to one end of the probe, and the sensor being arranged to trigger when the probe end reaches a predetermined temperature in excess of 300°C.

8. An electric heater unit for use with an electric hob, the unit comprising a generally planar electric heater element and control means comprising a thermally conductive elongate probe in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor connected thermally to one end of the probe for controlling the heat output of the element, the probe being a rod having at least one bend in a plane parallel to the plane of the element and within the boundary of the heater element as projected normally onto the plane of the probe.

9. An electric heater unit according to Claim 8, in which the sensor is an electric switch.

10. An electric heater according to Claim 8, in which the sensor is electronic and sends a signal to an electronic control circuit for controlling the heat output of the element.

11. Control means or a unit according to any preceding claim, in which the probe is of copper.

12. Control means or a unit according to any of Claims 1 to 10, in which the probe is of a copper alloy.

13. Control means or a unit according to Claim 12, in which the copper alloy includes chromium.

14. Control means or a unit according to Claim 11, 12 or 13, in which the probe is coated with a corrosion inhibitor.

15. Control means or a unit according to Claim 14, in which the corrosion inhibitor comprises nickel.

16. Control means or a unit according to any of Claims 1 to 10, in which the probe is of a ceramics material.

17. Control means or a unit according to Claim 16, in which the ceramics material comprises silicon carbide.

18. Control means or a unit according to Claim 16, in which the ceramics material comprises aluminium nitride.

19. Control means for an electric heater unit comprising at least one electric heater element positioned below a ceramic hob plate, the control means comprising a thermally conductive, generally cylindrical, elongate probe which in use is positioned below the hob plate in proximity to the heater element for exposure to the heat of the hob plate, and a thermally responsive sensor for controlling the heat output of the element, the sensor being connected thermally to one end of the probe, the said end of the probe having a surface profiled such as to be complementary to a corresponding surface of the sensor, the complementary surfaces being held in intimate thermal contact.

20. Control means according to Claim 19, in which the surface of the probe is flattened and is held in thermal contact with a flat surface of the thermally responsive sensor.

21. Control means or a unit according to any preceding claim, in which the probe is enclosed in a protective tube.

22. Control means or a unit according to Claim 21, in which the tube is of silica glass.

23. Control means or a unit according to Claim 21, in which the tube is of ceramic glass.

24. Control means or a unit according to any preceding claim in which the probe end and the or each sensor are enclosed in a thermally insulated casing.

25. Control means for an electric heater unit, substantially as described herein with reference to the accompanying drawings.

26. An electric heater unit for use with a ceramic hob, the unit comprising an electric heater element and control means in accordance with Claim 7 or 19, in which the sensor is connected to control the heat output of the element and the probe is positioned for exposure to the heat of the element.

27. An electric heater unit according to any of Claims 1 to 6, 8 to 18, 21 to 24, or 26, comprising a thermally-insulating casing around the element, which isolates thermally the sensor from the radiant heat from the element.

28. A ceramic hob comprising a ceramic hob plate positioned above an electric heater unit according to any of Claims 1 to 6, 8 to 18, 21 to 24, 26 or 27.

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